VIII. *Observations on the Structure of the Stomachs of different Animals, with a View to elucidate the Process of converting animal and vegetable Substances into Chyle.* *By* Everard Home, *Esq. F.R.S.*

Read April 30, 1807.

THE observations on the stomachs of the porpoise, and of ruminating animals contained in two former communications, led me to believe that the fourth cavity of the ruminant's stomach, while the animal is alive, is always divided, in a greater or less degree, into two portions, in one of which is included the plicated structure, in the other, the villous. In some genera, this division is permanent, as in the camel and that tribe; in others only occasional, as in the bullock, deer, sheep, &c.

If this opinion should be found to be true with respect to animals in general, it will throw considerable light on the processes carried on in the stomach, and lead us to conclude, that the food undergoes two changes in it, the one preparatory to the other, and that it is the last of these, which forms the chyle.

With a view to investigate still further this very interesting subject, I have been led to examine the internal structure of the stomachs of different animals.

In this enquiry it will be found that the same substances are digested by stomachs varying considerably from each other, and many of these varieties can at present in no other way be accounted for, than by referring them to the general principle, which pervades the structure of animals, making them run into one another by a regular series of minute changes of form, so as to compose one connected chain, from which we derive the fullest evidence of the power and wisdom of their Creator.

The stomachs of all ruminating animals have three different structures; the first of these is cuticular; the second has a secreting surface, thrown into folds, on which are seen the orifices of glands; and the third is smooth, and more delicate in its texture.

In the following account, it will be found that three similar structures are met with in the stomachs of quadrupeds which do not ruminate, and that the gradation between the most complex and most simple stomach forms an uniformly connected series, of greater extent than has been hitherto supposed.

To complete the view of this subject is too extensive a pursuit for an individual, whose professional duties occupy so large a portion of his time as mine necessarily do. All that can be expected from one so circumstanced is to give a general outline, leaving the minuter parts to be filled up by those who have more leisure, but by no means more zeal, for studies of this kind.

As these materials are collected not merely for the present investigation, but are intended for the use of future enquirers,

care has been taken that every anatomical fact brought forward, should be ascertained by actual examination.

It is proposed to describe the internal structure of such stomachs as appear to form the principal links in the gradation between animals which ruminate, and those which are truly carnivorous, arranging them in a series, the beginning of which is that nearest allied to the stomach of the ruminant, in the complexity of its parts, and the termination, that, which is most simple in its internal structure.

Before the appearances of these different stomachs are described, it will be necessary to explain the circumstances under which they were observed. As the object of the present enquiry is to determine with as much accuracy as possible the shape, the stomach puts on, while performing its functions in the living body, and the structure, which belongs to the different parts of its internal membrane, it became necessary to consider what would be the best mode of making such examinations. It was found that the stomach ought not to be in a distended state at the time of the animal's death, for when that is the case, the air which is let loose or even the shaking of the contents, elongates or stretches the muscular fibres, so as to enlarge the cavity, and give it a form, by no means natural to it. This partly arises from the weakness of the muscular fibres themselves; but principally from the effect of death upon this organ, which destroys the rigidity of its muscular fibres, so that they become easily elongated, even when much shortened at the time death takes place. It is necessary to mention this circumstance, as it is the reverse of what happens in the voluntary muscles, which are generally known to become rigid at that time, and it accounts for the

real form of the stomach having been much less frequently noticed, than was naturally to be expected.

To come at the real form of the stomach, it must be seen recently after death, before its muscles have been disturbed; in this state a gentle and gradual distension with air shews both the permanent divisions of its cavity, if there are any, in the best possible manner, and also any occasional muscular contractions, that are employed during life.

The internal membrane is only to be met with in a natural state recently after death, since the secretion from the solvent glands frequently acts upon it, and destroys the surface, and the slightest degree of putrefaction, which comes on very quickly in this cavity, prevents the nicer distinctions of structure from being detected.

To make an accurate examination of the different parts of this membrane, it is necessary that its folds should be extended, and the mucus commonly found adhering to it removed, which is most readily effected, and with the least disturbance, by inverting the stomach and gradually distending it; and in this state only can the relative situation of the different structures be ascertained with exactness.

In examining stomachs, with the attention directed to all the circumstances above mentioned, it is found that in a recent state, the internal membrane is often completely obscured by mucus, which in many instances is inspissated, and puts on the appearance of a cuticular covering, from which it is with difficulty distinguished; in others it resembles a fine villous surface, so very tenacious is its nature; and where the membrane is irregular it adheres with unusual firmness.

The internal membrane of most stomachs is found to be

considerably more extensive than any of the other coats, and much more so than it appears to be on a superficial examination; for it is not only thrown into longitudinal and transverse folds, but is subdivided by slight fissures into a number of small portions varying in shape and size in different parts of the same stomach, but generally smallest near the pylorus; this appearance was at first mistaken for the real internal structure of the membrane; but when inverted and distended, so as to be put upon the stretch all these disappeared, and it became very thin and smooth. This is seen most readily in the human stomach, and in those of carnivorous animals.

Such distension enables us to examine the internal structure of parts, but this is not to lead us away from their more natural appearance; since the functions of this membrane could no more go on were it unfolded to a great extent, than the muscular actions of the outer coat, in an over-stretched state of its fibres.

In proof of this observation, I have known an instance of a child three years old, who being left alone at dinner, ate so large a quantity of apple-pudding that it died, which raised suspicion of its having been poisoned. On examination after death, the whole stomach was distended to its utmost extent, and rendered quite tense, which was the only apparent cause of the child's death.

Having made these general remarks, which will render the following descriptions intelligible, without entering into detail on the mode of examining each particular stomach, I shall proceed to describe those stomachs, from which I mean to draw conclusions respecting digestion. The drawings, illustrate the appearances so well, that a short account

will be sufficient. They are all made by Mr. CLIFT, whose knowledge of anatomy has enabled him to delineate the different parts with a degree of correctness, which could not have been otherwise attained. As I so often avail myself of his talents, I am desirous of acknowledging on all occasions the benefit I derive from them. In procuring and examining the different stomachs, I have received material assistance from Mr. BRODIE.

No. I. *The Turkey.*

Immediately below the crop the œsophagus of the turkey is lined with a cuticle, and when narrowly observed a great many small orifices leading to glands belonging to that canal are very distinctly seen. This cuticular lining terminates in a line across the œsophagus, immediately above the solvent glands, or as they have been hitherto termed, the glands that secrete the gastric juice. The surface on which their ducts open is not cuticular, but membraneous; their orifices are placed in six rows across the canal. Each of them has a prominent or nipple-like appearance, and they are nearly at equal distances from each other. Immediately below the solvent glands is the entrance into the gizzard, composed of longitudinal ridges, covered with the same kind of horny cuticle which lines the sides of the gizzard itself.

At the lower orifice of the gizzard, just before the duodenum begins, there is a surface of about half an inch in extent, which has a delicate structure, composed of very minute parts; these are not distinct to the naked eye, but when magnified by a lens whose focus is $1\frac{1}{4}$ inch, they appear to be granules, separated by interstices from each other. This

portion I consider to belong to the stomach, and to form a part of the digestive organ. It terminates by a tolerably defined line, where the villous appearance of the duodenum begins. Vide Plate V. fig. 1.

No. II. *The Cod Fish.*

The stomach of the cod is a direct continuation of the œsophagus, from which its origin is only to be distinguished by the termination of the cuticular lining. It is made up of two cavities; one large, which I shall call the cardiac portion, the other small, which I shall call the pyloric. The cardiac cavity terminates in a rounded extremity; and on one side, a little above its termination, it communicates with the pyloric by a very narrow opening.

From the cuticular lining of the œsophagus project a number of small processes, as in the turtle, but formed on an infinitely smaller scale; these, when examined, do not appear to be tubular, any more than those in the turtle. The internal membrane of the cardiac portion is thrown into longitudinal folds of an irregular form, and there is a secretion of viscid mucus from every part of its surface; there are also numerous orifices distinctly seen on the prominent parts of these folds, which I consider to belong to the solvent glands. These are in greatest number towards the lowest extremity, but are met with towards the upper end.

The pyloric cavity has an internal surface of a very different kind; it resembles a fine honey-comb, or network. Vide Plate V. fig. 2.

No. III. *The Hare.*

The stomach of the hare, when forcibly distended, appears to be one nearly uniform cavity; but when examined immediately after death, before the parts have been disturbed, is found to have a partial contraction, dividing it into two; the cardiac portion is two-thirds and the pyloric portion is one-third of the whole cavity.

The muscular coat of the cardiac portion is weak, but at the division between it and the pyloric the fibres become much stronger: they are regularly circular, and continue so half way to the pylorus; there they form a thick projecting band, and afterwards become spiral, towards the pylorus. There are two layers of these spiral fibres in opposite directions, crossing each other, which gives them great power in their contraction, and very considerably increases its effect.

The internal membrane of the cardiac portion forms one uniform surface. Where the pyloric portion begins the membrane is thicker in its substance, and the surface more villous; further on, where it is surrounded by the projecting band, there are small distinct orifices, largest, and in greatest number on the lower curvature, but met with all round; these appear to be the excretory ducts of the glands, which secrete the solvent liquor. From this part to the pylorus, the surface is smoother, and has a more delicate texture.

The rabbit's stomach corresponds in every respect with that of the hare, only that the parts are on a smaller scale, and less conspicuous. The orifices of the ducts above described were

not detected in the rabbit till they had been seen in the hare, but then were readily distinguished. Vide Plate V. fig. 4 and 5.

No. IV. *The Beaver.*

The stomach of the beaver is divided by a muscular contraction into two portions; the cardiac, which is of an oval form, may be called the descending portion; the pyloric, which is much smaller, and bent upwards, may be called the ascending portion: the contraction between them is sufficiently strong to bear the force necessary to distend the stomach, without yielding to it. The cuticular lining of the œsophagus terminates at the orifice of the stomach. Just within that orifice, upon the upper or small curvature is a large oval glandular structure, subdivided into three prominent ridges, placed in the direction of the stomach, and projecting into its cavity, one in the middle line, and one on each side of it: in the middle ridge there are nine large openings through the internal membrane, capable of contracting so as to shut up the orifices, or of dilating so as to expose three inner orifices leading to the gland; each of these is continued into five or six processes, whose length is proportioned to the thickness of the glandular mass, extending nearly to its external surface. In each of the lateral ridges there are seven orifices. The internal membrane of the descending portion of the stomach, into which these excretory ducts open, is uniformly smooth in every other part of it; but the lining of the smaller ascending portion has a villous appearance, subdivided by slight fissures: this however is only to be seen when minutely examined. The part next the pylorus has a strong muscular covering

of some thickness, similar to what is met with in the hare and rabbit. Vide Plate VI. fig. 1, 2, and 3.

No. V. *The Dormouse.*

The stomach of the dormouse is divided into two portions by a muscular contraction, which is very distinct when examined immediately after death. At the orifice of the stomach there is a peculiarity shewn to me several years ago by Mr. MACARTNEY, which I had never seen till that time.

This peculiarity is a glandular substance, surrounding the œsophagus, immediately before it terminates in the stomach; the orifices of which open on the internal membrane of the œsophagus. Mr. MACARTNEY left me a drawing of the external appearance of the gland, when the stomach was in a distended state, in which the muscular contraction between the two portions was destroyed. He said nothing about the structure of the gland, and as it was a subject, which did not then engage my attention, I thought no more about it. In the course of the present enquiry it occurred to my recollection, and upon comparing this gland with that of the beaver (with which it corresponds very minutely in its internal structure) it becomes a fact of no small importance in forming a series of glandular structures belonging to the stomach: in making use of this fact, I have great pleasure in acknowledging the source, from whence my first knowledge of it was derived. This glandular structure viewed externally is like a mulberry, being made up of a number of small projections; the orifices in the membrane of the œsophagus admit of distension with air, and when expanded each orifice exposes three

small openings; these again lead to several processes, as has been described and delineated in the glandular structure of the beaver.

The first portion of the stomach forms about $\frac{2}{3}$ of the whole, while the second is only the remaining third; internally the membrane has no peculiar appearance, and is uniformly the same in both portions. The cuticular lining of the œsophagus terminates immediately above the glandular structure, which has just been described; so that the stomach of the dormouse is in all respects very similar to that of the beaver. Vide Plate VI. fig. 4 and 5.

No. VI. *The Water Rat.*

The stomach of the water rat is made up of two cavities with a narrow communication between them. The cavity into which the œsophagus opens is nearly two-thirds, and the other rather more then one-third of the whole. The stomach terminates at the pylorus by a very contracted orifice.

The first cavity has a cuticular lining continued from the œsophagus over the whole of its internal surface, terminating in a prominent serrated edge at the contracted part, except that on each side an oval portion of cuticle extends into the second cavity; this is seen through the other coats of the stomach. There are no apparent orifices in this cuticular lining leading to glands. The œsophagus opens into it obliquely, so that regurgitation can hardly take place.

The second cavity is lined with a membrane, which, at the lower part or greater curvature, is thicker than at any other; the surface is convoluted, and appears to secrete a thick viscid mucus; beyond this there is an irregular zone of orifices, which I consider to be the ducts of the solvent glands. From

this part to the pylorus the membrane is more smooth, and made up of minuter parts. Vide Plate VI. fig. 6.

No. VII. *The Common Rat.*

The stomach of the common rat has a general resemblance in its appearance to that of the water rat, but differs from it in having no permanent division between the two portions of which it is composed. When examined recently after death there is a contraction dividing it into two parts; but when distended this disappears, and the whole becomes one cavity; so that in this animal the division is only muscular, which in the water rat is permanent.

The first cavity bears a greater proportion to the whole than in the water rat; it is about $\frac{3}{4}$ instead of $\frac{2}{3}$. The first cavity is lined with a cuticle, which terminates in a line like a thread, formed by a doubling of the cuticular edge, but not projecting or serrated, as in the water rat. This line surrounds the stomach, but projects furthest on the lower part or great curvature, where it terminates in a point: there are also the two lateral cuticular processes as in the water rat, but less conspicuous from not being prominent, and much smaller.

The internal surface of the second cavity so entirely corresponds with that of the water rat, as to require no particular description; only the orifices of what I consider to be the solvent glands are less readily detected.

The stomach of the mouse is similar to that of the common rat in its general characters.

No. VIII. *The Horse.*

The stomach of the horse, as it is most commonly met with after death, appears to be an oval bag, the internal surface of

which, next the great end, is covered with a cuticle continued from the œsophagus, and extending further towards the pylorus on the small curvature than on the great one. The œsophagus enters obliquely; which prevents regurgitation from readily taking place. At the great curvature, immediately beyond the termination of the cuticle, which forms a prominent ridge, there is a glandular structure of some extent: this is insensibly lost in the more membranous portion, which extends to the pylorus, and appears to be a villous surface subdivided into small portions of unequal size, giving it a tesselated appearance.

When the horse's stomach is procured in an empty state, or nearly so, immediately after death, and is inverted and gradually distended, it is found to consist of two very distinct portions, there being a muscular contraction between the cuticular portion and the other.

No. IX. *The Ass.*

The stomach of the ass resembles that of the horse in all respects, and being of a more delicate structure its minuter parts are more easily distinguished. A number of orifices of glands immediately beyond the cuticular portion on the upper curvature are distinctly seen, which I was unable to distinguish in the horse; but there can be no doubt of their existence in that animal, although I was not so fortunate as to observe them. Vide Plate VII.

No. X. *The Kanguroo.*

The stomach of the kanguroo differs in many particulars from that of any other known animal, and bears a much greater resemblance to the human cœcum and colon than to any stomach.

The œsophagus enters the stomach very near its left extremity, which, unlike the corresponding part in other animals, is very small and bifid. From the entrance of the œsophagus the cavity extends towards the right side of the body; then passes upwards, makes a turn upon itself, crosses over to the left side before the œsophagus, and again crosses the abdomen towards the right, making a complete circle round the portion into which the œsophagus enters, and terminates by a contracted orifice at the pylorus.

Its cavity gradually enlarges from the left extremity through its whole course, till it approaches the pylorus; it then contracts and dilates again into a rounded cavity, with two lateral processes: beyond this is the pylorus, the orifice of which is extremely small. On the anterior and posterior side of the stomach there is a longitudinal band similar to those of the human colon, beginning faintly at the left termination, and extending as far as the enlargement near the pylorus: these bands being shorter than the coats of the stomach, the latter are consequently puckered, forming sacculi, as in the human colon.

When the cavity of the stomach is laid open, the cuticular lining of the œsophagus is found continued over the portion immediately below it, and extends to the termination of the smallest process at the left extremity, and nearly to the same distance in the opposite direction; the cuticular covering is very thin, and extremely smooth.

The lining of the larger process at the left extremity is thick and glandular, and in the living body probably receives no part of the food, but is to be considered as a glandular appendage.

On the right of the œsophagus the cuticle does not end by a transverse line, but terminates first upon the middle line of the great curvature, where a villous surface begins by a point, and gradually encreases in breadth till it extends all round the cavity: its origin therefore is in the form of an acute angle. This villous surface is continued over the remaining cavity as far as the longitudinal bands extend: and that half of it next the pylorus has three rows of clusters of glands: one row is situated along the great curvature, and consists of 15 in number; the other two rows are close to the two longitudinal bands, and consist only of nine. Besides these there are two larger clusters of an oblong form, situated transversely, where the longitudinal bands terminate. The internal surface of the rounded cavity next the pylorus has a different structure, putting on a tesselated appearance, formed by a corrugated state of the membrane. Immediately beyond the pylorus is a ring of a glandular structure surrounding the inner surface of the duodenum. Vide Plate VIII.

No. XI. *The Hog.*

The general form of the stomach is nearly that of the beaver; it is divided by a muscular contraction into two portions. The cardiac large and oval, its direction obliquely downwards; the pyloric small and conical, its direction upwards. There is a process continued from the cardiac extremity, turned back upon the upper part of the stomach, which terminates in a blunted end.

The cuticular lining of the œsophagus extends along the small curvature of the stomach in both directions, and terminates at the base of the process above-mentioned. This process is sometimes found contracted and quite empty, so that it does

not appear to form a part of the receptacle for food. The internal membrane of the cardiac portion of the stomach, as far as the opening of the œsophagus, is an uniform surface, but immediately beyond, on the lower side or great curvature, there is a thick glandular substance of an oval form, bounded laterally by two prominent ridges, one on each side, with a similar one in the middle line of the stomach: there are also three smaller passing transversely from the middle to the lateral ones. A small part of this glandular structure is situated in the pyloric portion, and where it terminates there is a row of large orifices leading to glands. These only extend round the upper part, and are not continued beyond the edge of the glandular structure. The pyloric portion has a smooth villous appearance. Vide Plate IX.

No. XII. *The Pecari.*

The stomach of the pecari differs from that of the common hog, in there being two processes at the cardiac extremity, and these having a more lateral direction; so that the stomach appears to be composed of three bags; one the general cavity, the others the two lateral processes; that which projects anteriorly is nearly double the size of the other. The cuticular lining of the œsophagus extends further on the sides of the general cavity of the stomach than in the hog.

XIII. *The Elephant.*

This stomach is longer and narrower than that of most other animals; the whole length is three feet three inches; and its diameter in the middle line, which is the widest part, is one foot two inches. The cuticular lining of the œsophagus terminates at the orifice of the stomach. The internal membrane of the stomach differs in appearance in different parts. At the cardia

which is very narrow, and pointed at its extremity, the lining is thick and glandular for eight inches in extent, and is thrown into transverse folds, of which five are broad and nine narrow; that nearest the orifice of the œsophagus is the broadest, and appears to act occasionally as a valve, so that the part beyond may be considered as an appendage, similar to the processes in the hog and pecari; the membrane of the cardiac portion is uniformly smooth, that of the pyloric is thicker and more vascular.

These observations, as well as the engraving, are made from a dried preparation. Vide Plate X.

XIV. *The Mole.*

The cavity of the stomach when distended is of a globular form, and I have had no opportunity of examining it recently after death so as to ascertain where the division takes place between the cardiac and pyloric portions. Its coats are very thin and transparent. The œsophagus opens into it midway between the two extremities.

The cuticular lining of the œsophagus terminates at the orifice of the stomach. The internal membrane is uniformly smooth except at the pylorus, where it is surrounded by a glandular zone immediately within the orifice, the surface of which has a granulated appearance.

XV. *The Stoat.*

The stomach when distended has a globular form; its coats are thin and transparent; I have not seen it in an undisturbed state; the œsophagus opens into it nearly midway between the two extremities.

The inner membrane has an uniformly smooth appearance, except near the pylorus, where it is thicker and has a glandular structure, the surface of which is granulated. This differs from that in the mole, by being spread over a surface of some extent, and the glands being deeper seated behind the internal membrane.

No. XVI. *The Armadillo (with nine Bands.)*

The stomach has an oval form; the œsophagus opens into it nearer to the pylorus than in many other animals.

The cuticular lining of the œsophagus terminates at the orifice of the stomach. The cavity of the stomach is divided into two portions by a muscular contraction. The surface of the cardiac portion is uniformly smooth, but in the pyloric portion, for the space of an inch and three quarters from the pylorus, the muscular coat is thicker and more compact, and immediately within the orifice of the pylorus there is a zone of a glandular structure surrounding it; the orifices leading to the glands are very apparent.

The animal, from which this description is taken, was given to me by Lord SEAFORTH. It died on the passage from the West Indies, and was immediately preserved in spirits; the parts did not admit of a drawing being made of them, but were in a more natural state respecting their contraction than in other animals where the stomach has been so long kept as to be distended with air.

No. XVII. *The Human Stomach.*

The human stomach, when examined recently after death, puts on appearances, that have not been noticed, which makes

the present description, and the drawing that accompanies it, necessary to explain these circumstances. It is occasionally divided by a muscular contraction into two portions; these are in shape, and relative size, sometimes similar to those of the beaver, at others to those of the horse. When its internal surface is accurately examined under the most favourable circumstances, the orifices of the œsophageal glands are distinctly seen in different parts, but more numerous just above where the cuticle terminates at the orifice of the cardia. Immediately within the cavity of the stomach, there are clusters of glands, exceedingly small and pellucid, crowded on one another, spread over the internal membrane of the small curvature for several inches in extent, but no where else. To have a distinct view of them requires the use of a magnifying glass; but when once observed, they are seen with the naked eye. The cardiac portion has an uniform surface, but towards the pylorus there is a more minute structure, very much resembling the appearance of a tesselated pavement, composed of very small portions of different forms. Vide Plate XI. fig. 1.

XVII. *The Lynx.*

The stomach was in a very flaccid state and quite empty. When inverted and gently distended with air its form resembles that of the beaver, only the pyloric portion is more bent upon the small arch.

The cuticular lining of the œsophagus terminates exactly at the orifice of the stomach by a serrated edge, and is thrown into a number of transverse folds. Immediately within the orifice of the stomach, and extending along the small arch, there are clusters of glands, resembling in appearance and

situation those described in the human stomach, but upon a larger scale and more obvious to the naked eye. Beyond this part, the internal membrane of the cardiac portion has one uniformly smooth surface studded over with glands, particularly along the great curvature. The pyloric portion has a number of glands of a different structure more minute than those of the cardiac portion; these are placed principally along the surface of the small arch, and are continued on to the pylorus, where there is a zone of glands surrounding the termination of the stomach, and the origin of the duodenum.

In this animal these glandular structures are very conspicuous, which are not to be detected in the domesticated carnivorous animals. Vide Plate XII. fig. 1.

XVIII. *The Vampyre Bat.*

The animal from which the stomach was taken was nine inches long, the extent of its wings 36 inches.

The œsophagus swells out before it enters the general cavity, and that dilatation from its internal structure appears to belong to the stomach, as there is no contraction, or distinct orifice beyond it. To the left of the œsophagus there are two dilatations with a neck between them; the furthest of these has a smooth surface and the coats are very thin; in the other there are several deep longitudinal rugæ, some of which are continued into similar rugæ, or bands in the dilated portion of the œsophagus. This portion of the stomach has more the appearance of an appendix than belonging to the general canal. There are six rugæ or bands in the œsophageal portion, four of which are continued towards the pylorus, giving a direction to the food in that course. After the stomach

has extended the same length on the left of the œsophagus as on the right, it is turned back upon itself, as far as the entrance of the œsophagus, then makes another turn, and ends in the pylorus by a very small valvular opening, which scarcely gives a passage to air when in a contracted state. No part of the stomach is lined with a cuticle, and a quarter of an inch from the pylorus, there is an appearance of glandular structure; this is very faint in consequence of the animal having been long kept in spirits. This animal occasionally feeds on flowers, since stamina resembling those of Eugenia, were found filling up several portions of the stomach, the filamentæ and antheræ in a perfect state. Vide Plate XI. fig. 3.

XIX. *Long-eared Bat.*

The animal from which the stomach was taken was $2\frac{1}{4}$ inches long, and the tail included in the web about two inches. The wings extended nine inches. The œsophagus is extremely small, and lined with a cuticle which termates at the orifice of the stomach. The general cavity is distinctly divided into a cardiac and pyloric portion: close to the pylorus, and surrounding it, there is an appearance of small glands.

In the spectre bat there is a swell in the œsophagus as in the vampyre; so that in the different species of bats the stomachs vary very much from one another. Vide Plate XI. fig. 2.

XX. *The Hawk.*

The stomach is a direct continuation of the œsophagus, distinguished from it by the termination of the cuticular lining, and by the solvent glands having their origin at that part. These are disposed in four longitudinal ridges; they appear

to be made up of an infinite number of small white tubes, the direction of which is perpendicular to the internal membrane. The cavity of the stomach is divided into two portions; the cardiac is the largest, forms the general cavity, and when in a contracted state, has a rugous internal surface: the pyloric is small, and projects from one side of the other. Immediately beyond the pylorus the duct of the liver opens. Vide Plate XII. fig. 2 and 3.

XXI. *The Cormorant.*

The stomach is formed on the same general principle as that of the hawk; but the solvent glands differ so much in their appearance from those of other birds of prey, that I have represented them in the annexed drawing. The cuticular lining of the œsophagus terminates at the orifice of the stomach, and several openings of the œsophageal glands are seen at that part. Immediately within the stomach are situated the solvent glands, forming two circular projecting surfaces, each of them $1\frac{5}{8}$ inch in diameter, covered with small orifices like pin holes, which extend into the substance of the gland. The communication with the pyloric portion is on one side just below these solvent glands. Vide Plate X. fig. 2 and 3.

XXII. *The Viper.*

The stomach is a continuation of the œsophagus: its origin is distinguished by the termination of the cuticular lining of that canal, the coats becoming thicker at that part, and the inside being surrounded by a zone of solvent glands. The cardiac portion terminates in a small orifice at its lower part, and the pyloric is through its whole extent not wider than this orifice; its internal membrane has longitudinal folds; but

immediately beyond the pylorus, where the duct of the liver opens, the duodenum has a different structure. Vide Plate XIII. fig. 1.

XXIII. *The Turtle.*

The stomach is a continuation of the œsophagus, and begins where the projecting papillæ of that canal terminate. The cardiac portion is of an oval form, has a rugous internal surface, but no distinct glands were observed; it communicates with, the pyloric by a small orifice; the pyloric is bent upwards and retained in that situation by the mesogaster; its coats are very thick, and their substance contains many small glands with ducts leading into its cavity. Vide Plate XIII. fig. 2.

XXIV. *The Frog.*

The stomach is in its general characters like that of the turtle, but on a very small scale, and no particular glandular structures were distinguished. Vide Plate XIII. fig. 3.

XXV. *The Blue Shark.*

The œsophagus is three inches long, and lined with a cuticle. The cardiac portion of the stomach is 18 inches long and 8 in diameter; it communicates with the pyloric by an orifice $\frac{1}{8}$ of an inch in diameter. The pyloric portion is 18 inches long and one inch in diameter. The fish was 7 feet 5 inches long.

The internal membrane of the cardiac portion is rugous, and orifices leading to glands are seen upon it. That of the pyloric portion is smooth. Beyond the pylorus there is an enlargement where the intestine begins, and into this cavity the duct of the liver opens. Beyond this the spiral valve of

the gut has its origin. The spleen surrounds both the cardiac and pyloric portion, and is represented in the engraving. Vide Plate XIII. fig. 4.

The description of the stomach of the cod fish by mistake is placed the second of these descriptions.

Observations on the Stomachs which have been described.

In the stomachs of ruminating animals, the processes the food undergoes before it is converted into chyle, are more complex than in any others. It is cropped from the ground by the fore teeth, then passes into the paunch, where it is mixed with the food in that cavity; and it is deserving of remark, that a certain portion is always retained there; for although a bullock is frequently kept without food seven days before it is killed, the paunch is always found more than half full; and as the motion in that cavity is known to be rotatory by the hair balls found there being all spherical or oval with the hairs laid in the same direction, the contents must be intimately mixed together; the food is also acted on by the secretions belonging to the first and second cavities; for although they are lined with a cuticle, they have secretions peculiar to them. In the second cavity these appear to be conveyed through the papillæ, which in the deer are conical (Vide Plate V. fig. 3), and when examined by a lens whose focus is $\frac{1}{2}$ inch, they are found to have three distinct orifices, and that part of each papilla next the point is semitransparent. These secretions are ascertained by Dr. STEVENS's experiments to have a solvent power in a slight degree, since vegetable substances contained in tubes were dissolved in the paunch of a sheep.*

* *Dissertatio Physiologica inauguralis de Alimentorum concoctione. Autore* EDWARDO STEVENS, Edinb. 1777.

The food thus mixed is returned into the mouth, where it is masticated by the grinding teeth; it is then conveyed into the third cavity, in which it would appear from the gas * let loose, that a decomposition takes place, and thence it is received into the upper portion of the fourth cavity.

The changes which are produced on the food in the three first cavities are only such as are preparatory to digestion, and it is in the fourth alone that process is carried on. In the plicated portion the food is acted on by the secretion of the solvent glands; and in that portion of the fourth cavity of the deer's stomach small orifices are seen in the internal membrane leading to cavities, the size of a pin's head, which I consider to be the openings of these glands, since they bear some resemblance to those of other stomachs. In the lower portion the formation of chyle is completed.

In birds with gizzards the food goes through very similar changes; it is picked up by the bill, which in the smaller birds separates the husk from the seed; it then passes into the crop, where it is acted on by the secretions of that cavity, after which it is received into the gizzard, to undergo the same change produced by the grinding teeth of the ruminants; the secretion of the solvent glands is then poured upon it, acting upon the nutritious part before it is spread upon the glandular structure at the orifice of the gizzard, in which last situation it is formed into chyle.

In the whale tribe, the first cavity, although lined with a cuticle, has secretions peculiar to it, and therefore corresponds with the first and second of the ruminants, and with the crops of birds with gizzards: it answers however a further

* Mr. Davy and Mr. W. Brande examined this gas, and found it to be inflammable, and not to contain carbonic acid; which establishes a difference between this process, and fermentation.

purpose, by dissolving its contents sufficiently to prevent the necessity of rumination, or the use of a gizzard. The second cavity performs the same office as the plicated portion of the fourth cavity of the ruminant, and the fourth is that in which the chyle is formed. This complex structure of the stomach in the whale tribe, although it gives it an appearance of great similarity to that of the ruminant, is not at all formed on the same principle, since the additional cavities in the ruminant are to prepare the food for the process of digestion; while in the whale tribe no such preparation is required; but as the fishes they feed upon are swallowed whole, and have large sharp bones which would injure any surface not defended by cuticle, a reservoir became necessary, in which they may be dissolved and converted into nourishment, without retarding the digestion of the soft parts. The very narrow communication between the second, third, and fourth cavities, resembles the opening between the cardiac and pyloric portion in fishes.

The stomachs of this tribe of animals are therefore introduced here, as being next in order with respect to the complexity of parts, and having by the division of them led me to the present investigation, although it is by no means their proper place, with respect to their mode of digestion.

The animals, nearest allied to the ruminants in their mode of digestion, are those which, like them, retain a portion of food in the cardiac extremity of the stomach, that it may undergo a change, before it is submitted to the action of the solvent liquor; and when so hard as to render it necessary, return it again into the mouth, to be masticated a second time.

The hare and rabbit are of this kind; the cardiac portion of the stomach is never completely emptied, and they occa-

sionally ruminate. In proof of both these facts, a rabbit, which had been seven days without food, died, and the cardiac portion of the stomach was found to contain more than half of its usual quantity of contents: they were rather softer than common, and a number, amounting to 50 or 60 of distinctly formed pellets the size of shot, were collected together in the cardiac extremity, immediately below the œsophagus. These could not have been formed at the time of eating, since in seven days, the action of the stomach would have destroyed their shape. They must therefore have acquired it by the animal chewing the cud.

This second class of ruminants have no cuticular lining to their stomachs, which may arise from their being more cautious feeders than the others, so that they are not liable to receive into the stomach any thing which can injure its internal membrane. All that portion of the stomach, which corresponds with the first cavity in the true ruminant, has one uniform structure, and is covered by a viscid mucus, but beyond this there are orifices, which I believe belong to solvent glands of a very small size; and towards the pylorus, the glandular appearance is of a different kind; so that in these stomachs the changes the food goes through correspond very closely with those it undergoes in ruminants.

The next order of animals with respect to digestion consists of the beaver and dormouse. These, both in the shape and general appearance of the stomach, as well as of the teeth, bear a close affinity to the hare; but they have a glandular structure peculiar to them, which seems to correspond with the solvent glands of other animals; and as the dormouse empties

its stomach completely, there is reason to believe that the beaver does so likewise, and that neither of them ruminate, since the regurgitation of the food would be attended with difficulty from the situation of these glandular structures; and it is probable, as they do not ruminate, the increased secretion of a solvent liquor renders it unnecessary.

The changes the food undergoes in these stomachs are only two; it is acted on by the secretion from the solvent glands, and afterwards converted into chyle by the secretion of those near the pylorus. This is a less complex process than in many of the stomachs not yet taken notice of, and is exactly similar to what takes place in carnivorous animals; it may therefore be considered as a connecting link between the ruminating and carnivorous stomachs.

After these, which form a regular series from the ruminants, are the stomachs with cuticular reservoirs, in which the food is macerated, before it is submitted to the process of digestion. Animals of this kind are the water-rat, in which there is a permanent division between the cuticular cavity and the digestive part of the stomach; the common rat and the mouse, in which there is only a muscular one. The cuticular lining is thick and impervious; beyond it is a glandular part, that secretes a mucus found adhering to its surface; and further on are orifices, which appear to belong to the solvent glands. These animals do not ruminate, and there is a kind of provision in nature to prevent regurgitation of the food. When kept without food for several days they completely empty their stomachs.

The horse and the ass, although animals in all other res-

pects different, correspond so very closely in the structure of their stomachs with the rat and mouse, that their stomachs must be considered of the same kind.

In these the food is rendered easy of solution by remaining in the cuticular reservoirs; it is then acted on by the solvent liquor, and in the pyloric portion converted into chyle.

The stomach of the kanguroo, from the peculiarities of its structure, forms an intermediate link between the stomachs of animals which occasionally ruminate, those which have a cuticular reservoir, and a third kind not yet noticed, with processes or pouches at their cardiac extremity, the internal membrane of which is more or less glandular. The kanguroo is found to ruminate, when fed on hard food. This was observed by Sir JOSEPH BANKS, who has several of these animals in his possession, and frequently amused himself in observing their habits. It is not however their constant practice, since those kept in Exeter Change have not been detected in that act. This occasional rumination connects the kanguroo with the ruminant. The stomach having a portion of its surface covered by cuticle, renders it similar to those with cuticular reservoirs; and the small process from the cardia, gives it the third distinctive character; indeed it is so small, that it would appear placed there for no other purpose.

The kanguroo's stomach is occasionally divided into a greater number of portions than any other, since every part of it, like a portion of intestine, can be contracted separately; and when its length, and the thinness of its coats are considered, this action becomes necessary to propel the food from one extremity to the other. Such a structure of stomach makes regurgitation of its contents into the mouth very easily per-

formed. The food in this stomach goes through several preparatory processes; it is macerated in the cuticular portion; it has the secretion from the pouch at the cardia mixed with it; and is occasionally ruminated. Thus prepared, it is acted on by the secretion of the solvent glands, which probably are those met with in clusters in the course of the longitudinal bands and afterwards converted by the secretions near the pylorus into chyle.

The animals, whose stomachs have processes or pouches at their cardiac extremity, are the kanguroo, hog, pecari, hippopotamus, and elephant.

The pecari's stomach bears the nearest resemblance to those with cuticular reservoirs, having a portion of its surface lined with cuticle; but it only extends to a small distance from the termination of the œsophagus, and is not continued over any part of the great curvature.

The hippopotamus's stomach I have never seen, and DAUBENTON's description and engravings are taken from that of a fœtus; so that the structure of its minute parts is imperfectly known; but there is no doubt of there being a large pouch on each side of the cardiac portion, and there is reason to believe that no part of the cavity of the stomach is lined with cuticle.

The elephant's stomach is the most simple of this kind. It has no cuticular lining; the elongation at the cardia is only a continuation of the general cavity, distinguished from it by the membranous septa; and the broad one may act as a valve, and occasionally preclude the food from passing.

In these stomachs the pouches at the cardia can only be connected with the preparation of the food, softening it by means of their secretions, or retaining it within their cavities;

the other glandular structures are similar to those in the ass and rat, only more conspicuous.

It is deserving of remark, that the internal structure of the stomachs fitted for digesting vegetable substances, corresponds much less with the kind of teeth, than it has been generally supposed to do. The animals with chissel teeth have no uniformity in the structure of their stomachs; those of the beaver and dormouse being of one kind; the hare's and rabbit's of another; the squirrel's of a third, resembling that of the monkey; the guinea pigs of a fourth, differing from that of the squirrel, in there being a greater disproportion between the thickness of the coats of the cardiac and pyloric portions; the rat tribe of a fifth, which resembles the stomach of the horse and ass, animals whose teeth have a very different form.

On the other hand, all the ruminants with horns have one structure of stomach; all those with fighting teeth another, as has been observed in a former paper; also all the animals with projecting tusks have the pouches at the cardia, which appear to be peculiar to them, although there is no connexion we yet know of between these weapons of defence and the stomach.

As the elephant's grinding teeth are the best fitted for preparing vegetable food for digestion, so the stomach in its structure approaches nearer to those of carnivorous animals.

The stomachs whose structure has been hitherto considered belong to animals that feed on vegetables, and chiefly on the leaves, roots, and branches of plants. In the gradation towards carnivorous stomachs, we are next to take notice of those that belong to animals whose principal food is the fruits of trees, which appear to require less preparation for the process

of digestion; of this kind are the stomachs of the squirrel and monkey. These in their general appearance resemble very closely the human stomach; at least the few opportunities which have occured to me of examining them, have not enabled me to detect any circumstances in which they differ.

The human stomach appears to be the uniting link between those that are fitted only to digest vegetable substances, and those that are entirely carnivorous; and yet we find in its internal structure it is in every material respect similar to those of the monkey and squirrel, which only digest vegetable productions, and also equally similar to those of carnivorous animals. From this it would appear that many parts of vegetables are as easily digested as animal substances, and require the same organs for that purpose; but others again require a particular preparation, without which they cannot be converted into chyle; of these last the principal are the grasses, which the human stomach is unable to digest.

The human stomach is divided into a cardiac and pyloric portion, by a muscular contraction similar to those of other animals; and as this circumstance has not before been taken notice of it, may be necessary to be more particular in describing it.

The first instance, in which this muscular contraction was observed in the human stomach, was in a woman, who died in consequence of being burnt. She had been unable to take much nourishment for several days previous to her death. The stomach was found empty, and was taken out of the body at a very early period after death. It was carefully inverted to expose its internal surface, and gently distended with air. The appearance it put on has been already described. The con-

traction was so permanent, that after the stomach had been kept in water for several days in an inverted state, and at different times distended with air, the appearance was not altogether destroyed.

Since that time I have taken every opportunity of examining the human stomach recently after death, and find that this contraction in a greater or lesser degree is very generally met with. The appearance which it puts on varies: sometimes it resembles that of the ass (Vide Plate VIII.) so that this effect is not produced by a particular band of muscular fibres, but arises from the muscular coat in the middle portion of the stomach being thrown into action: and this for a greater or lesser extent, according to circumstances. When this part of the stomach is examined by dissection, the muscular fibres are not to be distinguished from the rest.

If the body is examined so late as 24 hours after death, this appearance is rarely met with, which accounts for its not having before been particularly noticed.

PERRAULT found a contraction somewhat similar in a lion's stomach, which appeared to him extraordinary, as it was only met with in one instance out of four, that were examined. He gives a drawing of the appearance, but makes no comments on the cause of the contraction.*

* La conformation du ventricule étoit particulière, et bien différent en ce sujet de celle, que nous avons trouvés aux autres lions, que nous avons dissequés, où le ventricule étoit semblable à celui des chiens et des chats; ayant un fond ample et large vers l'orifice supérieur qui alloit toujours en s'étrecissant vers le pylore; mais celui-ci avoit le fond separé en deux, en quelque façon comme les animaux qui ruminent. Ce forme particulière du ventricule n' étoit qu'en un seul des quatre animaux de cette espèce que nous avous dissequés, sçavoir deux lions et deux lionnes.

Mémoires pour servir à l'Histoire Naturelle des Animaux, dressez par M. PERRAULT, Fol. Ed. 1676.

Finding this contraction was met with, when the human stomach was nearly empty, I endeavoured to produce it in the cat, by having the stomach emptied by means of an emetic a short time before the animal's death. This did not however succeed; for although in the contracted state the line between the cardiac and pyloric portions was very distinct, and the last more contracted than the former, yet upon distending the stomach with air, the middle portion relaxed equally with the rest. The contraction at this part is therefore only to be seen, when these fibres have acted independently of the others; which takes place while the functions of the stomach are going on, but cannot be artificially produced.

In examining the stomach of a dog in a contracted state, and afterwards when it was distended, the line between the two portions could be distinctly perceived, even after the contraction was destroyed, by the longitudinal folds of the internal membrane of the pyloric portion all terminating there.

That the food is dissolved in the cardiac portion of the human stomach, is proved by that part only being found digested after death; the instances of which are sufficiently numerous to require no addition being made to them. This could not take place unless the solvent liquor was deposited there. Mr. HUNTER goes so far as to say, in his paper on this subject, "there are few dead bodies in which the stomach at its great "end is not in some degree digested."

That the chyle is not formed there, and also that it is completely formed before the food passes through the pylorus, is proved by the result of some experiments of Mr. HUNTER'S made upon dogs in the year 1760; and as they were instituted for a very different purpose,—that of determining whe-

ther the gastric juice is acid or alkaline,—the results were detailed without any possible bias.

The stomachs of seven dogs were examined immediately after death, which took place while digestion was going on; and among other observations the following appear among Mr. HUNTER's notes made at the time:

"In all the dogs the food was least dissolved or even mixed "towards the great end of the stomach, but became more and "more so towards the pylorus; and just within the pylorus, "it was mixed with a whitish fluid like cream, which was also "found in the duodenum."

He afterwards adds; "It is plain that digestion is com- "pleted in the stomach, as none of the crude food is found "beyond that cavity; and even within the pylorus there is the "same white fluid that is met with in the duodenum."

From the result of these experiments, as well as from the analogy of other animals, it is reasonable to believe that the glands situated at the termination of the cuticular lining of the œsophagus, which have been described, secrete the solvent liquor, which is occasionally poured on the food, so as to be intimately mixed with it before it is removed from the cardiac portion: and the muscular contraction retains it there till that takes place.

Such contraction being occasionally required in the stomach, accounts for its being more or less bent upon itself, which renders it more readily divided into two portions by the action of the muscular fibres at that part where the angle is formed.

It accounts for men occasionally ruminating, a process, which without such a contraction, could hardly take place. That some

men ruminate, the accounts of authors are sufficiently explicit to put beyond all doubt; particularly the instances collected by PEYER from FABRICIUS *ab aquapendente* and others, as well as from his cotemporaries, in all six or seven instances. Of these, two were examined after death. In one of them the œsophagus was unusually muscular, but nothing particular was met with in the stomach: in the other, nothing is said of the œsophagus, but the internal surface of the stomach was very rough.

The fact, however, does not rest on these authorities, since a case of this kind has come within my own observation.

The instance to which I allude, is a man 19 years of age, blind, and an ideot from his birth, who is now alive. He is very ravenous, and they are obliged to restrict him in the quantity of his food, since, if he eats too much, it disorders his bowels. Fluid food does not remain on his stomach, but comes up again. He swallows his dinner, which consists of a pound and a half of meat and vegetables, in two minutes, and in about a quarter of an hour he begins to chew the cud. I was once present on this occasion. The morsel is brought up from the stomach with apparently a very slight effort, and the muscles of the throat are seen in action when it comes into the mouth; he chews it three or four times, and swallows it; there is then a pause, and another morsel is brought up. This process is continued for half an hour, and he appears to be more quiet at that time, than at any other. Whether the regurgitation of the food is voluntary or involuntary, cannot be ascertained, the man being too deficient in understanding to give any information on the subject.

This contraction of the stomach also explains the circum-

stance of its contents not being completely discharged, by the first effect of an emetic, which only empties the cardiac portion: the contraction preventing the pyloric portion from being emptied till the violence of the straining ceases, at which time relaxation takes place.

It may also enable us to account for many symptoms that occur in the diseases of this organ, particularly the violent cramps, to which it is liable: as from the situation of the pain they probably arise from preternatural contractions of these muscular fibres. On the other hand, the indigestion met with in debilitated stomachs may proceed from this part having lost its proper degree of action, and therefore the food is not retained in it so as to be acted on by the different secretions.

This however is not the place to enter into these subjects; the object of the present investigation has been to collect facts in comparative anatomy, that may throw light upon the conversion of the food into chyle, and to abstain as much as possible from all matters of opinion;—no easy forbearance in going over ground, that has given rise to so many theories, and which the mind cannot contemplate, without forming a variety of conjectures.

The stomach of the truly carnivorous quadruped appears to be made up of the same parts as the human. In the lynx, the different structures are more strongly marked, the solvent glands are more conspicuous, the pyloric portion is more bent, which renders the division between it and the cardiac more distinct, the muscular coats of the pyloric portion are much stronger, and on its internal surface, glands are very obvious which are not to be observed in the human.

The stomachs of some carnivorous animals have glandular

structures peculiar to them; these are in the pyloric portion; there are also similar glands in the stomachs of some graminivorous animals, as has been already explained. The following may be mentioned as instances of this kind.

In the lynx, a glandular zone surrounds the orifice of the pylorus.

In the mole, there is a similar zone.

In the stoat, and armadillo, there is a glandular structure near the pylorus.

In the sea otter, there is a glandular structure extending from the pyloric portion into the duodenum, described in a former paper.

In tracing the gradation from carnivorous quadrupeds to birds of prey, it would have been natural to expect that the bat, which has wings, and lives on animal food, should form an intermediate link: this, however, is not the case; the stomach of the long-eared bat resembles those of small carnivorous quadrupeds; that of the vampyre bat, which will be found to live on vegetables, has more the appearance of an intestine, and may, from its form, be mistaken for the cæcum and colon; in this repect it approaches the kanguroo, and still more closely the kanguroo rat; its cardiac portion is shorter, and its pyloric longer, than in the stomach of that animal, and there is no valvular structure at the orifice of the cardia. I have mentioned these differences as there is no engraving of the kanguroo rat's stomach annexed to the present Paper.

The only real link between the stomachs of quadrupeds and birds is that of the ornithorinchus, which, however, is more an approach to the gizzard, being lined with a cuticle,

containing sand, and having the same relative situation to the œsophagus and duodenum. The food of this animal is not known; it is probably of both kinds; the papillæ at the pylorus, which appear to be the excretory ducts of glands, are peculiar to it.

The stomachs of birds of prey are formed upon the same principle as those of carnivorous quadrupeds, but their cavity is more a continuation of the œsophagus, and the solvent glands are more conspicuous and numerous. Both these differences may be accounted for from their swallowing their prey whole, or nearly so; which requires a more direct passage into the stomach, and a greater quantity of secretion from the solvent glands, than when the food has undergone mastication. The cardiac portion of these stomachs is very distinct from the pyloric.

In snakes, turtles, and fishes, the stomachs have the same characters as in birds of prey, but the cardiac and pyloric portions are still more distinct from each other, and the solvent glands are in general distributed over a larger surface of the cardiac portion.

From the series of facts and observations which have been adduced, the following conclusions may be drawn.

That the solvent liquor is secreted from glands of a somewhat similar structure in all animals, but much larger and more conspicuous in some than others.

That these glands are always situated near the orifice of the cavity whose contents are exposed to their secretion.

That the viscid substance found on the internal membrane, of all the stomachs that were examined recently after death, is reduced to that state by a secretion from the whole surface

of the stomach which coagulates albumen. This appears to be proved, by every part of the fourth cavity of the calf's stomach having the property of coagulating milk.

This property in the general secretion of the stomach, leads to an opinion, that the coagulation of fluid substances is necessary for their being acted on by the solvent liquor; and a practical observation of the late Mr. HUNTER, that weak stomachs can only digest solid food, is in confirmation of it.

That in converting animal and vegetable substances into chyle, the food is first intimately mixed with the general secretions of the stomach, and after it has been acted on by them, the solvent liquor is poured upon it, by which the nutritious part is dissolved. This solution is afterwards conveyed into the pyloric portion, where it is mixed with the secretions peculiar to that cavity, and converted into chyle.

The great strength of the muscles of the pyloric portion of some stomachs, will, by their action, compress the contents, and separate the chyle from the indigestible part of the food.

In animals whose food is easy of digestion, the stomach consists of a cardiac and pyloric portion only; but in those whose food is difficult of digestion, other parts are superadded, in which it undergoes a preparation before it is submitted to that process.

Fig. 1.

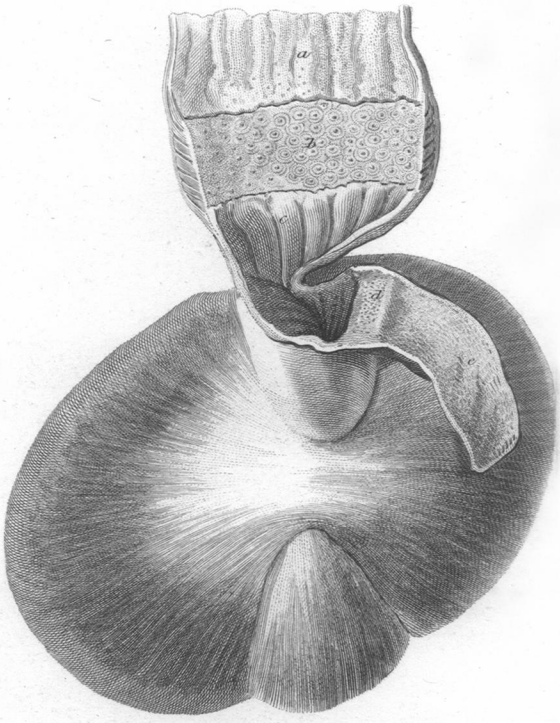

Fig. 3.

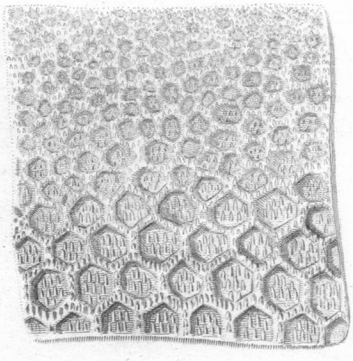

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Fig. 2.

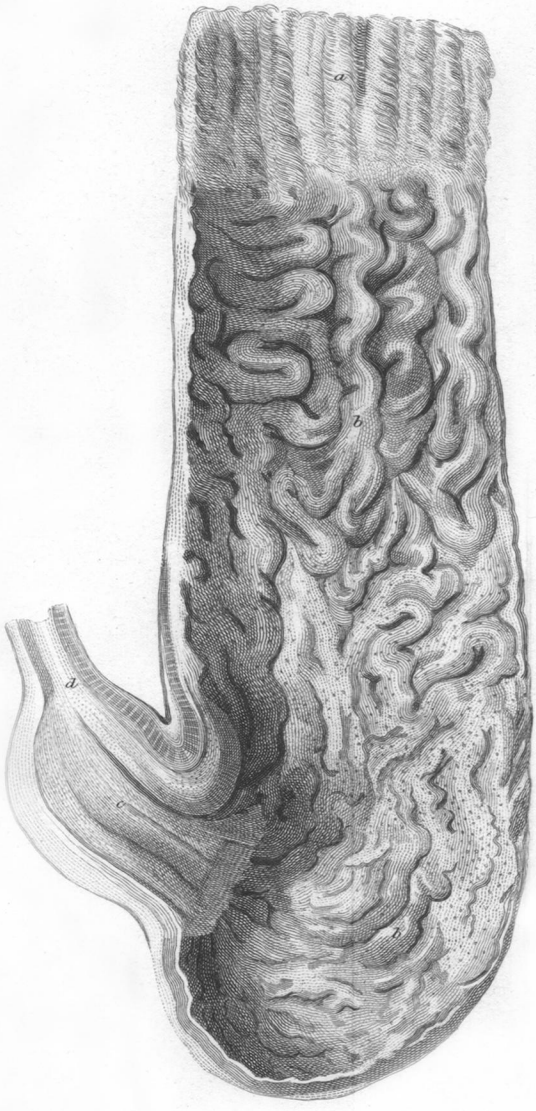


Fig. 2.

Fig. 4.

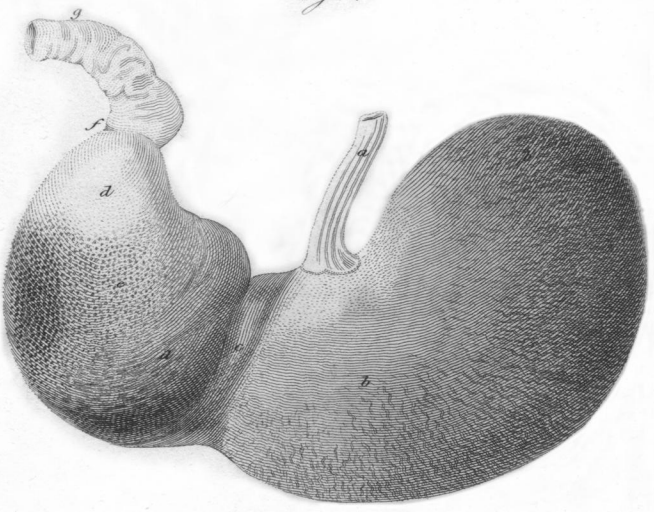
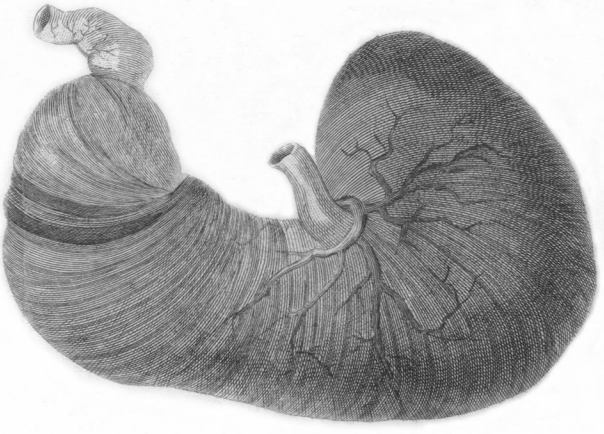


Fig. 5.



EXPLANATION OF THE PLATES.

(PLATE V.)

Fig. 1. Represents the gizzard of a turkey, with a portion of the œsophagus and duodenum attached to it. The œsophagus and duodenum are both laid open to expose different glandular structures, but the gizzard itself is entire.

a. The œsophagus immediately below the crop covered with a cuticle.

b. The openings of the solvent glands placed on a surface which has no cuticular covering.

c. Horny ridges between the solvent glands and the lining of the gizzard.

d. A minutely granulated surface between the cavity of the gizzard and the duodenum.

e. The inner surface of the duodenum.

Fig. 2. Shows the internal surface of the stomach of the cod fish.

a. The inner surface of the œsophagus lined with a cuticle, having small processes projecting from it.

b b. The cardiac portion of the stomach, the inner membrane of which is soft and rugous, forming longitudinal folds, and having orifices of glands upon the projecting ridges.

c. The pyloric portion.

d. The pylorus.

Fig. 3. Represents a small portion of the inner surface of the second cavity of the deer's stomach, showing the shape of the cells and the form and situation of the papillæ.

Fig. 4. Represents the hare's stomach inverted, to show its natural form, and the appearance of the different parts of its internal membrane.

a. The œsophagus.

b b. The cardiac portion.

c. A muscular band separating the cardiac from the pyloric portion.

d d. The pyloric portion.

e. A glandular appearance believed to be the solvent glands.

f. The pylorus.

g. The duodenum.

Fig. 5. Is an external view of the rabbit's stomach distended with air, to show the muscular coat; the fibres are uniformly of the same strength over the whole of the cardiac portion, but where the pyloric portion begins they are stronger, and continue so half way to the pylorus, at which part there is a circular band, and beyond it the fibres become spiral to the pylorus; the layers of spiral fibres decussate one another.

(PLATE VI.)

Fig. 1. Is a view of the beaver's stomach inverted, to show its shape and the appearance of the internal membrane.

a. The œsophagus.

b b. The cardiac portion.

c. The glandular structure peculiar to this stomach, which appears to be a cluster of solvent glands.

d. The contraction between the cardiac and pyloric portion.

e. The pyloric portion.

f. A glandular zone at the pylorus.

g. The duodenum.

Fig. 2.

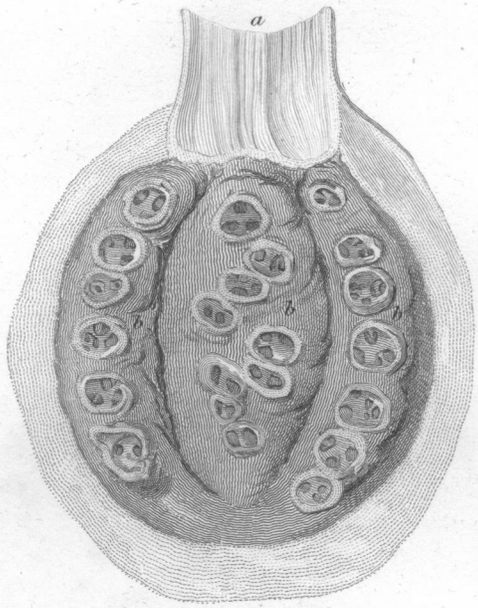


Fig. 4.

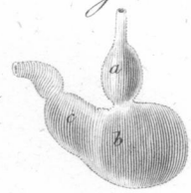


Fig. 5.

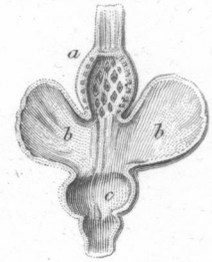


Fig. 6.

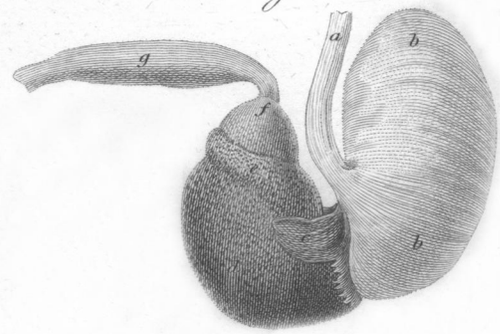


Fig. 3.

Fig. 1.

W. Clift del.

Basire Sc.

Fig. 2. Represents the orifices of the glandular structure, to show how much they admit of being dilated, and that in that state they expose three internal openings leading into the substance of the gland.

a. The œsophagus.

b b. The three ridges of glandular structure.

Fig. 3. Shows the different processes which belong to two of the three internal openings of the gland.

Fig. 4. An external view of the stomach of the dormouse, to show its peculiar glandular structure at the termination of the œsophagus, and the cardiac and pyloric portions of the stomach.

a. The glandular structure in the œsophagus.

b. The cardiac portion of the stomach.

c. The pyloric portion.

Fig. 5. The dormouse's stomach laid open to expose its internal surface.

a. The orifices of the gland corresponding to those of the beaver.

b b. The two corresponding parts of the cardiac portion of the stomach.

c. The pyloric portion.

Fig. 6. Is a view of the stomach of the water-rat inverted, to show its internal structure.

a. The œsophagus.

b b. The cardiac portion covered with cuticle.

c. A process of cuticle on each side extending into the pyloric portion.

d. A glandular structure.

e. Orifices of glands believed to secrete the solvent liquor.

f. The pylorus.

g. The duodenum.

(PLATE VII.)

A view of the ass's stomach inverted, to show its internal surface.

a. The œsophagus.

b b. The cardiac portion lined with cuticle, the termination of which is distinctly seen.

c c. A glandular structure.

d. The orifices of solvent glands.

e. The pylorus.

(PLATE VIII.)

An internal view of the stomach of the kanguroo, which exposes one half of its cavity.

a. The œsophagus.

b. Its termination in the stomach.

c c. The surface covered with cuticle.

d. The process at the cardia, which is glandular.

e e. The termination of the cuticular lining.

f f. The longitudinal band.

g g. The beginning of the clusters of glands which appear to secrete the solvent liquor.

h. The cavity at the pylorus.

i. The pylorus.

k. The duodenum.

(PLATE IX.)

Represents an internal view of the hog's stomach by inverting its cavity.

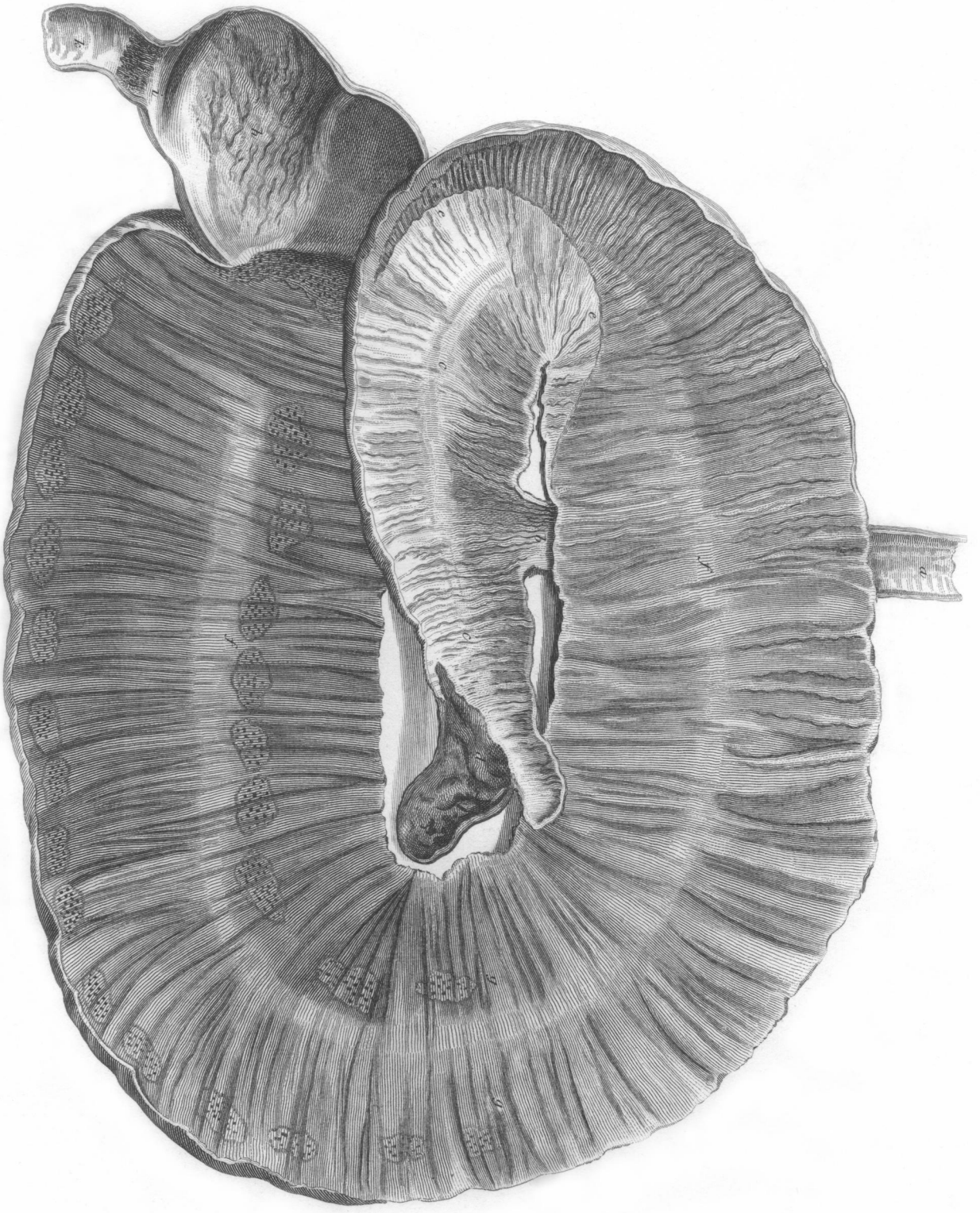
a. The œsophagus.

b b. The surface covered with cuticle.

½ Inch to an Inch.

W. Clift del.

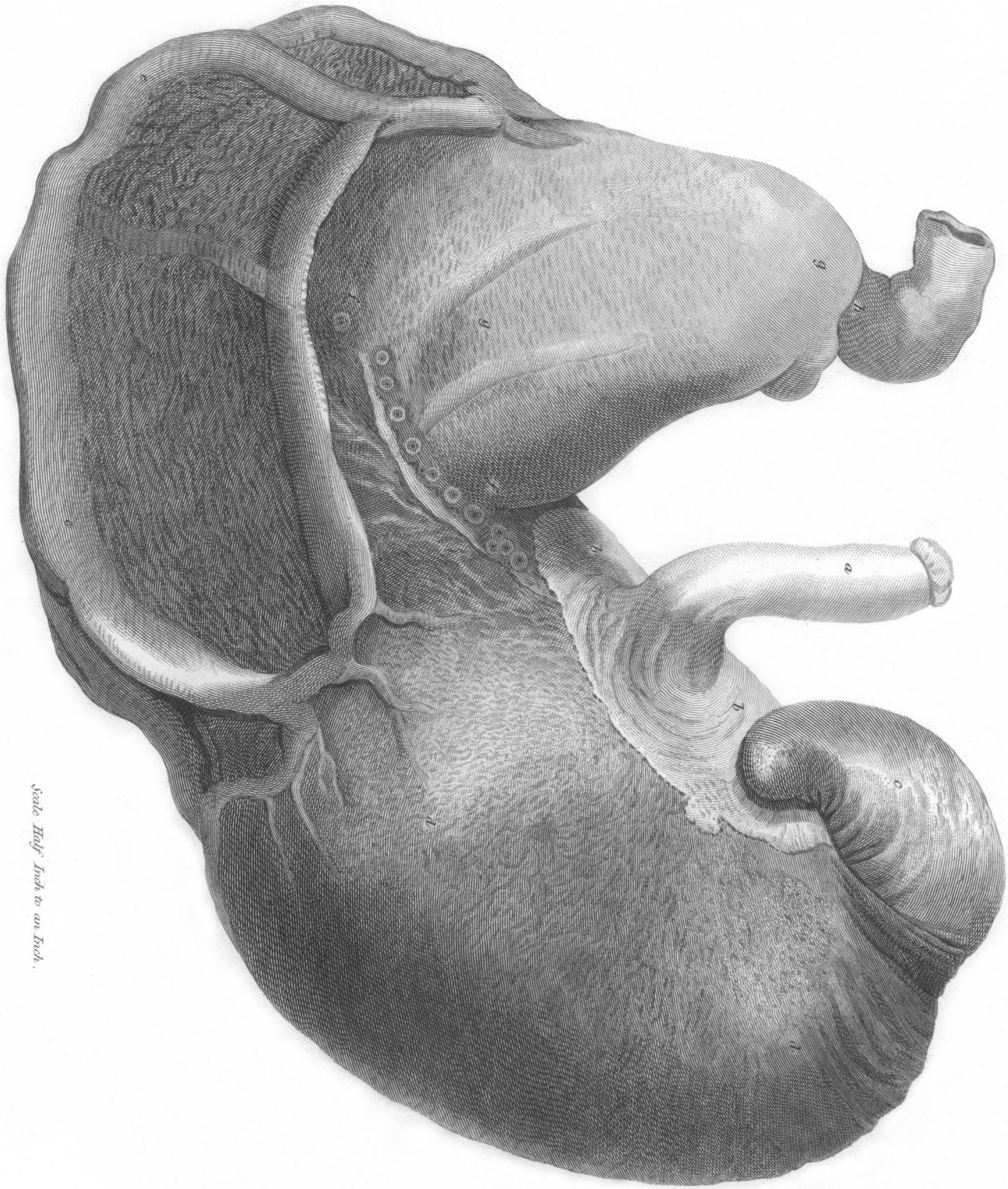
Basire Sc.



Scale Half Inch to an Inch.

W. Clift del.

Basire Sc.



Scale Half Inch to an Inch.

W. Clift del. *Basire Sc.*

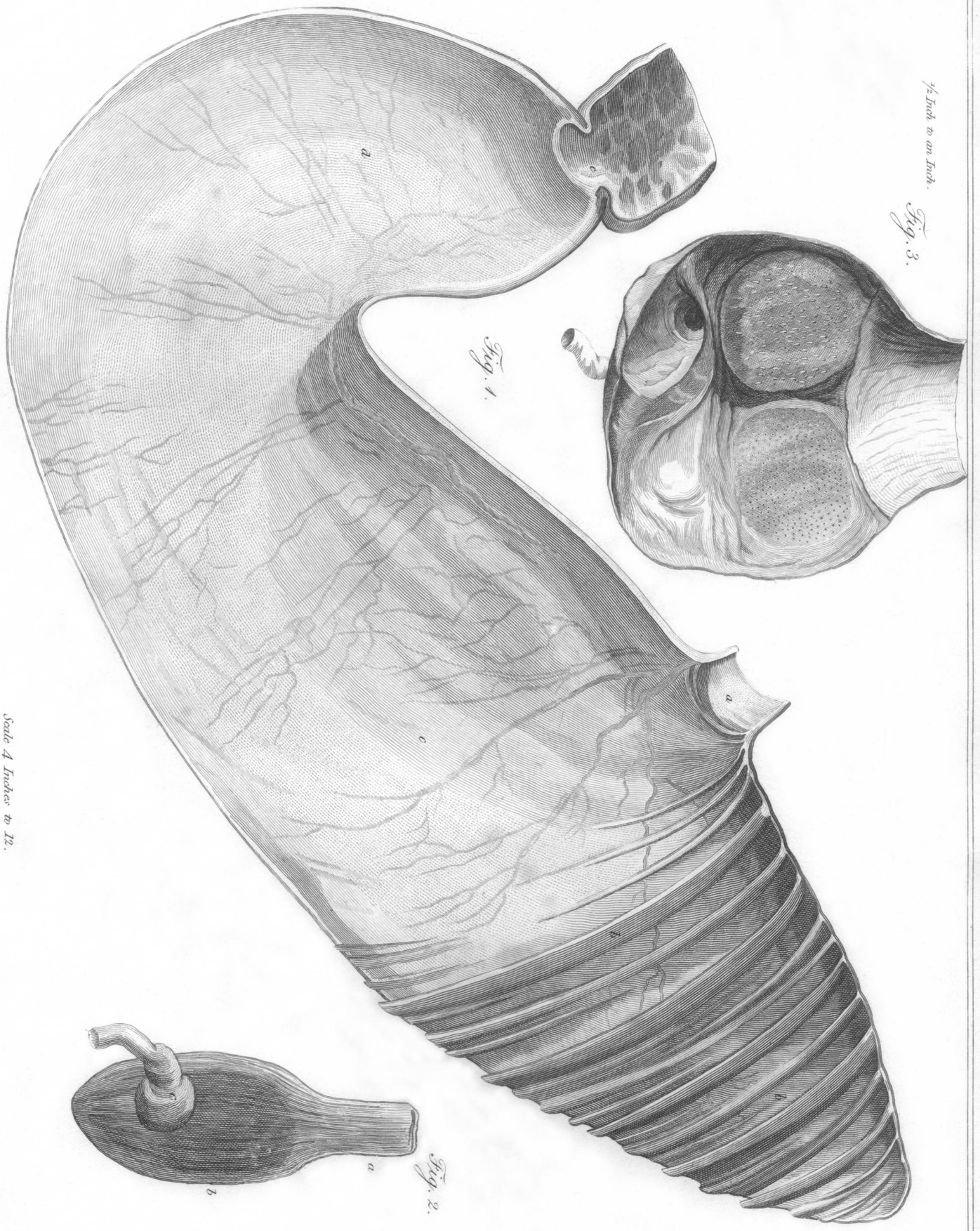


Fig. 1.

½ Inch to an Inch.

Fig. 3.

Scale 4 Inches to 12.

Fig. 2.

W. Clift del.

Basire Sc.

c. The process at the cardia.

d d. The surface of the cardiac portion.

e e. The massy glandular substance between the cardiac and pyloric portions.

f f. The orifices of solvent glands.

g g. The pyloric portion.

h. The pylorus.

(PLATE X.)

Fig. 1. Represents a section of the elephant's stomach, to show its internal structure, taken from a dried preparation, in which the blood vessels had been injected and the cavity afterwards blown up.

a. The œsophagus.

b b. The portion at the cardia, in which the transverse folds are met with: five of these are broad, and nine narrow.

c c. The cardiac portion.

d. The pyloric portion.

e. The pylorus.

Fig. 2. Shows the external appearance of the cormorant's stomach.

a. The œsophagus.

b. The cardiac portion.

c. The pyloric portion.

Fig. 3. Is the stomach laid open, and the internal parts exposed, particularly the solvent glands, the appearance of which differs from that of other birds of prey. On one portion the orifices are seen empty, on the other they are covered with mucus in a coagulated state.

(PLATE XI.)

Fig. 1. The human stomach inverted, to show its internal surface.

a. The œsophagus with its cuticular covering, and the orifices of the œsophageal glands, which are most conspicuous just above the termination of the cuticular lining.

b b. The cardiac portion.

c. The solvent glands.

d. The contraction, dividing the cardiac from the pyloric portion.

e. The pyloric portion.

f. The pylorus.

Fig. 2. A longitudinal section of the vampyre bat's stomach, to shew its internal surface.

Fig. 3. The stomach of the long-eared bat inverted, to show its internal surface.

(PLATE XII.)

Fig. 1. The lynx's stomach inverted, to show its internal surface.

a. The œsophagus, in which the internal membrane is thrown into folds in a transverse direction.

b b. The cardiac portion.

c. The solvent glands.

d. The pyloric portion.

e. The pylorus.

f. The duodenum.

Fig. 2. The external appearance of the stomach of the hawk.

a. The œsophagus.

W. Clift del.

Basire Sc.

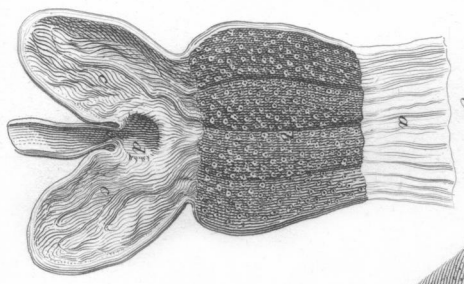


Fig. 3.

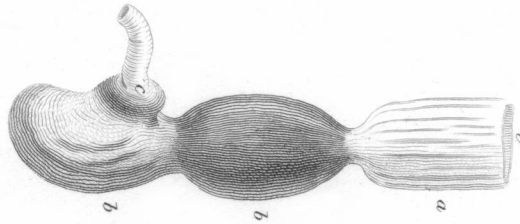


Fig. 2.

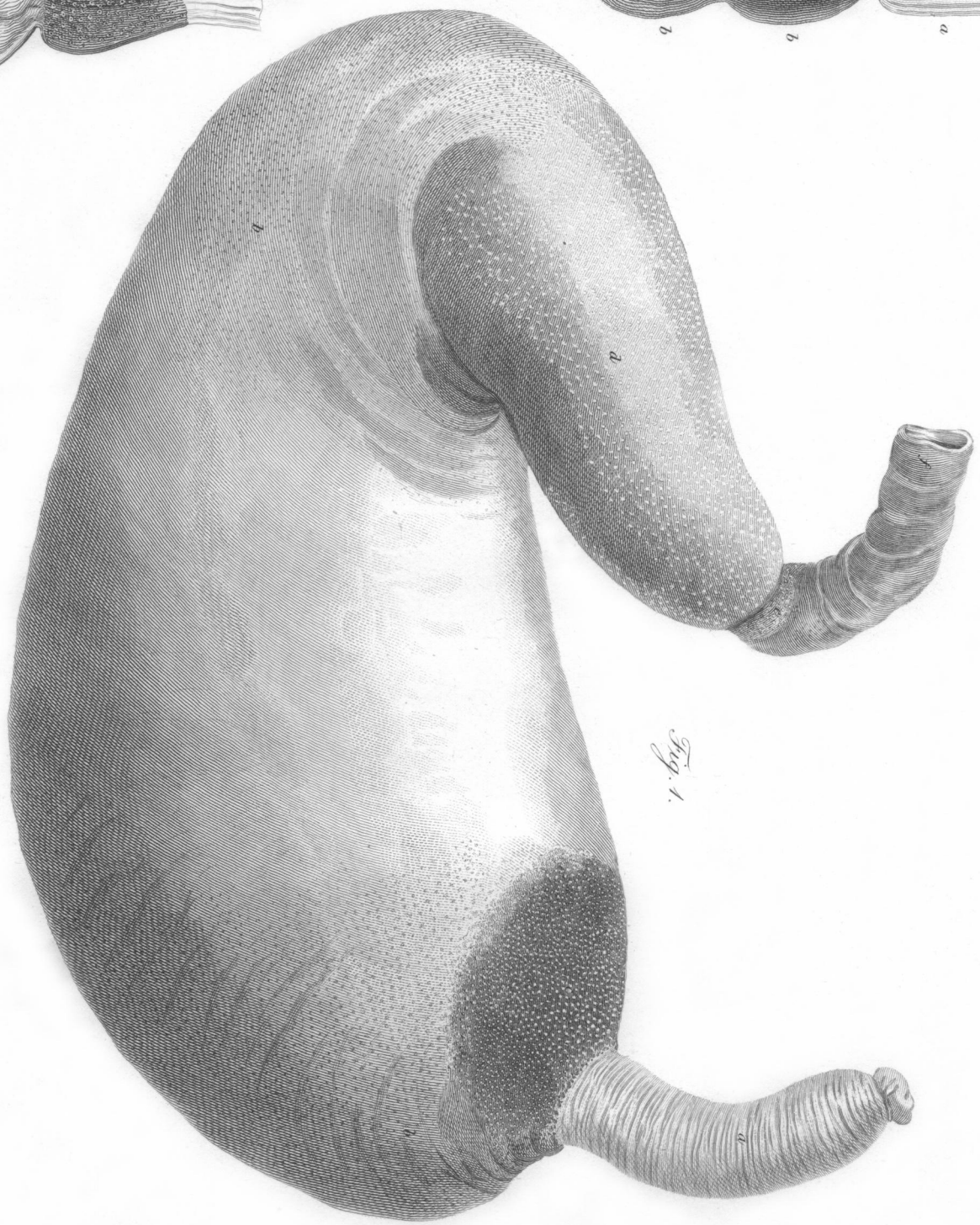


Fig. 1.

¾ Inch to an Inch.

Fig. 4.

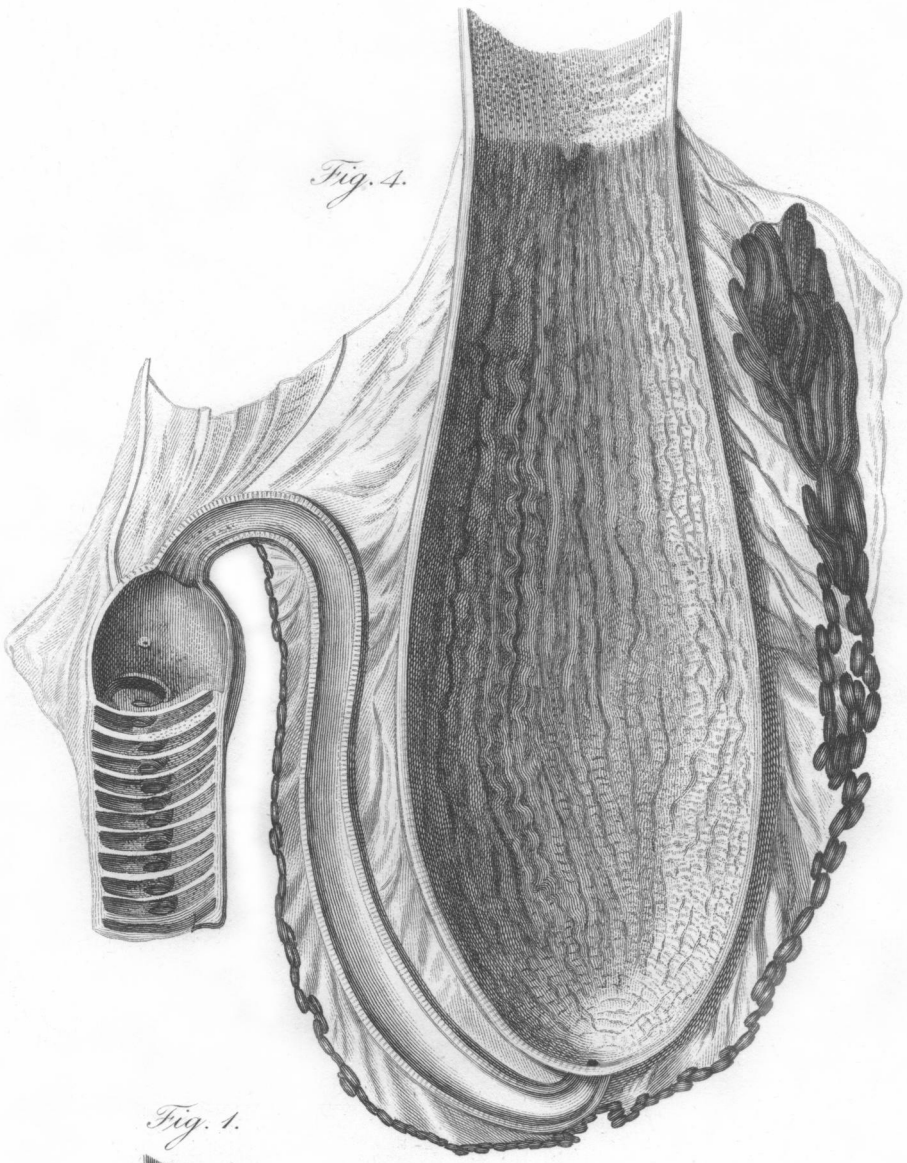


Fig. 2.

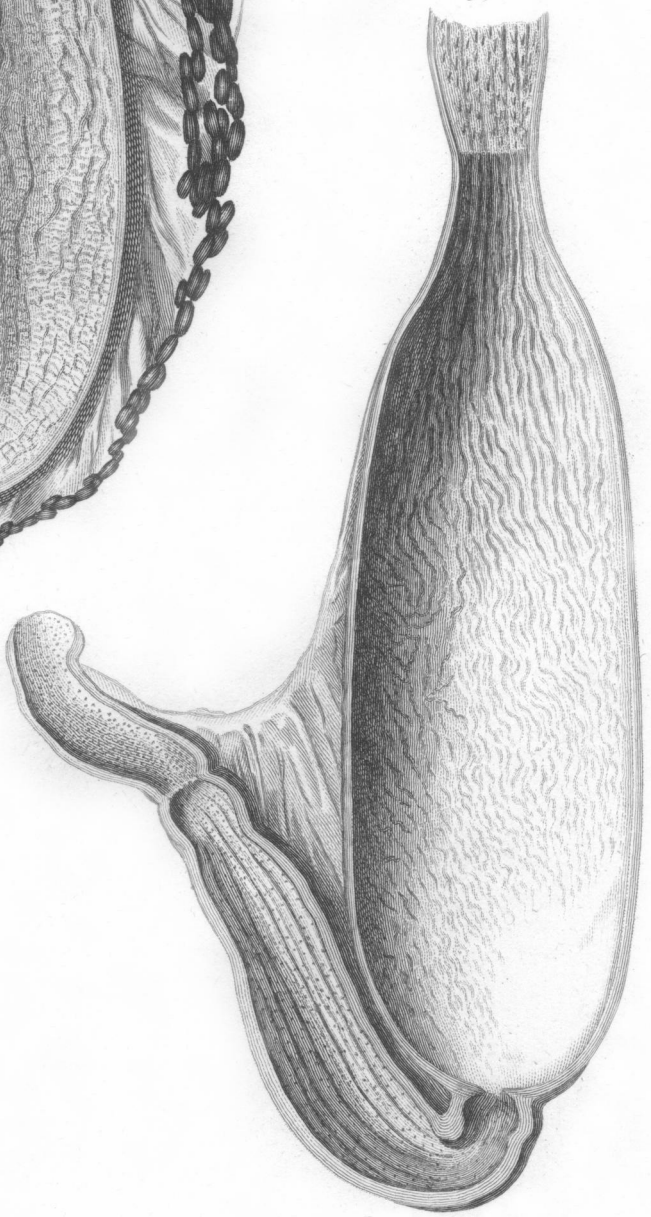


Fig. 1.

Fig. 3.

Half an Inch to an Inch.

W. Clift del.

Basire Sc.

b b. The cardiac portion.

c. The pyloric portion.

Fig. 3. The internal appearance.

a. The œsophagus.

b. The solvent glands.

c c. The cardiac portion.

d. The pyloric portion. At the beginning of the duodenum is the opening of the duct of the liver.

(PLATE XIII.)

Fig. 1. The stomach of the viper laid open, to show its internal surface.

Fig. 2. The stomach of the turtle, exposing one half of its cavity.

Fig. 3. The stomach of the frog, exposed in the same manner.

Fig. 4. A longitudinal section of the stomach of the blue shark. This fish was caught at Hastings, and purchased for me by my friend Col. Bothwell of the Scotch Greys, who happened to be there.

It is proper to remark, that previous to inverting the different stomachs, an opening was made at the cardia, to prevent the inversion from injuring the internal parts; this opening was afterwards sewed up in such a manner as to be air-tight, and then the stomach was distended.

Where the parts are not represented of their natural size, the proportions in which they are reduced are marked upon the Plate.